SMART ADVICE TO CHARGE NOTIFICATION

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 14/871,856, filed Sep. 30, 2015 and published on Dec. 8, 2016 as U.S. Patent Publication No. 2016-0357654, which claims priority under 35 U.S.C. § 119(e) of U.S. Patent Application No. 62/172,015, filed Jun. 5, 2015, and entitled "SMART ADVICE TO CHARGE NOTIFICATION," which is incorporated herein by reference to the extent that it is consistent with this disclosure.

TECHNICAL FIELD

This disclosure relates to the field of determining that an electronic device needs to be charged. Specifically, the disclosure is directed to systems and methods that advise a user to charge the electronic device.

BACKGROUND

A modern battery-powered electronic device can monitor the charge level of one or more batteries in the electronic device. Typically, when the battery level falls below a predetermined threshold value of remaining charge, then the electronic device notifies the user with a message such as "battery low" or other visual and/or audible indicator of the remaining charge level.

Often, a "battery low" indication that is based on a fixed threshold of charge remaining is not received in time for the user to take a corrective action. For example, if a user typically charges her smart phone at night, but forgets to do so on one occasion, receiving a "battery low" indication just before leaving for work the next day does not leave the user time to charge her phone before work.

SUMMARY OF THE DESCRIPTION

Embodiments are described for learning energy usage and charging patterns of a user of an computing system. By detecting a user's patterns in charging, and analyzing current and past state of charge information, it can be determined whether a user will run out of energy before her next charge. Given a current state of charge of an energy storage device computing system, a notification can be sent to the user if there is a high probability that the user is unlikely to make it until the next high probability charge time. For example, if the computing system notifies a user to charge at a fixed value of 10% remaining charge, and it is determined that the user typically charges at 10:00 p.m., and it is now 10:00 p.m., and the energy storage device currently has 30% remaining charge, then the user will not receive a notification to charge based upon the fixed charge level of the energy storage device. However, if analysis of the current, and stored, state of charge information indicates that the user will not make it to their next high probability charge time without running out of energy, the computing device can display an advice to charge notification at 10:00 p.m., even though the current state of charge is greater than the fixed threshold of 10% remaining energy.

In an embodiment, a computing system for predicting when a user will charge an energy storage device in a computing system can include one or more energy storage devices, a charging system, a real-time clock, one or more data storage devices, an energy measurement system, and an "advice to charge" module. The energy measurement system can measure current state of charge of an energy storage device and store the measurement in a state of charge database on a storage device. State of charge of the energy storage device can be measured periodically, in intervals, such as 15 minutes. State of charge data can be date-time stamped using the real-time clock. A database of computing system activities can be generated as the computing system is used. Activities can be based on sensor data, such as a location sensor, time of day, whether the computing system is in motion, and whether the charging system is currently plugged into a wall outlet. The "advice to charge" module can analyze the state of charge information to determine when a user is likely to charge and whether the energy storage device will have a level of charge remaining that is below a predetermined threshold amount before the next forecasted charging time.

In an embodiment, a method of generating state of charge information can include measuring and storing, at a plurality of regular intervals, a state of charge of one or more energy storage devices used by a computing system of a user. In an embodiment, state of charge information can be date/time stamped. In an embodiment, a current location of the computing system can be detected and stored. The location can be anonymized. The location can be stored in association with the current state of charge information stored at the time the location was detected. In an embodiment, a location of one or more other computing systems of the user can be detected and stored.

In an embodiment, a method of advising a user to charge a computing system can include querying a database of state of charge data for a plurality of intervals of time. From the state of charge data, a state of charge curve for the computing system can be generated over the plurality of intervals of time. The plurality of intervals of time can be selected to overlap a current time, and a similar past time, such as one week ago, two weeks ago, or three weeks ago. The plurality of intervals of time can alternatively be selected as being of a similar type of day as the current day, such as a work day or weekend day. In an embodiment, a rate of charge histogram can be generated over the same plurality of intervals as the state of charge curve. In an embodiment, an acceleration of charge histogram can be generated. Using current state of charge and one or more of the state of charge curve, rate of charge histogram, or acceleration of charge histogram, a time can be determined, with high probability, at which the user is likely to next charge the energy storage device in the computing system. A time at which the energy storage device will have a level of energy that is less than a predetermined threshold amount, unless charged at the forecast time, can also be determined. If the energy storage device will be below the predetermined threshold amount of charge before the next forecast charge, then a responsive action can be taken. In an embodiment, the user can be notified that he is advised to charge soon.

In an embodiment, a first computing system of a user can acquire state of charge information about a second computing system of the user. The first computing system can determine the current state of charge of an energy storage device in the second computing system and a state of charge curve from the state of charge information over a plurality of time intervals. The first computing system can also predict when the energy storage device in the second computing system will have less than a predetermined of charge remaining, if not charged by a time determined by the first computing system. The first computing system can take a